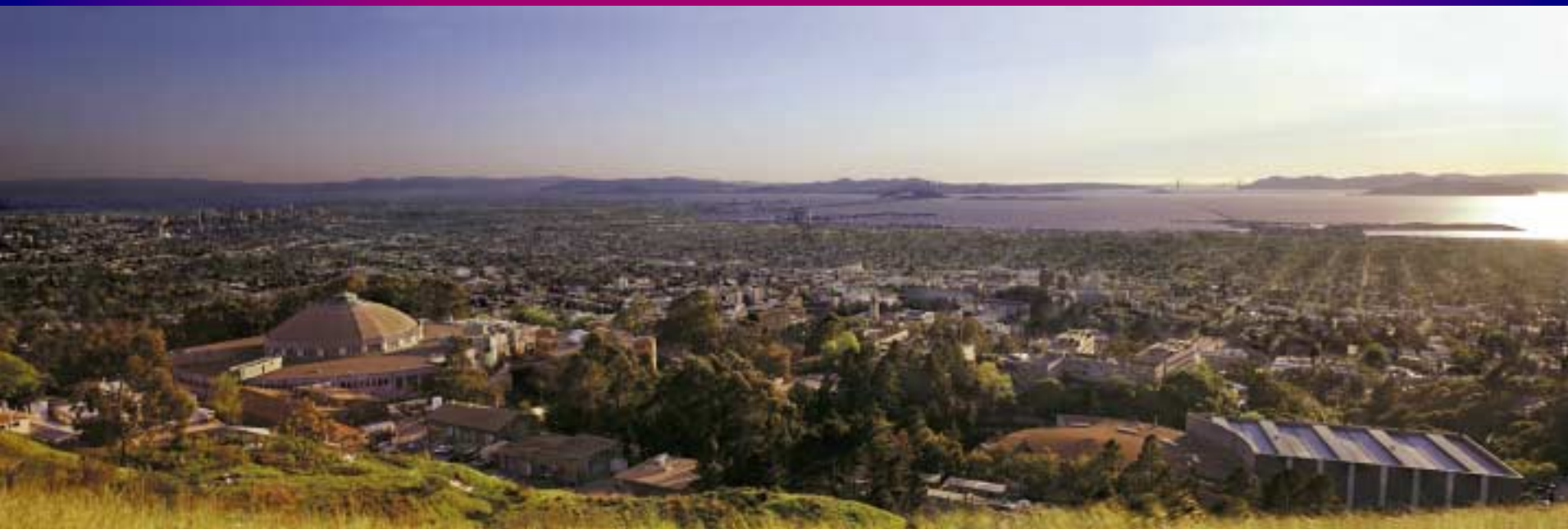


Presentation to HDDC, and Oracle Corporation Energy Efficiency Opportunities in Data Centers



**Tengfang (Tim) Xu, Ph.D., PE
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January 15, 2004**

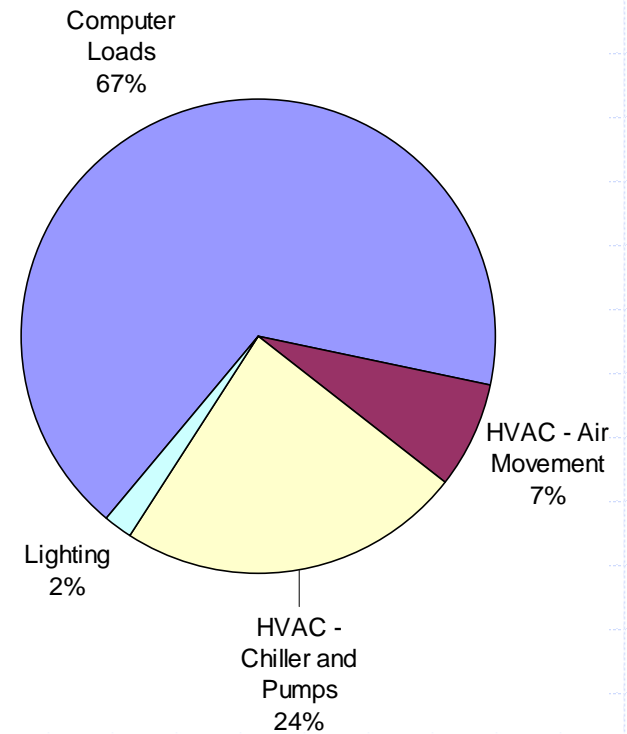
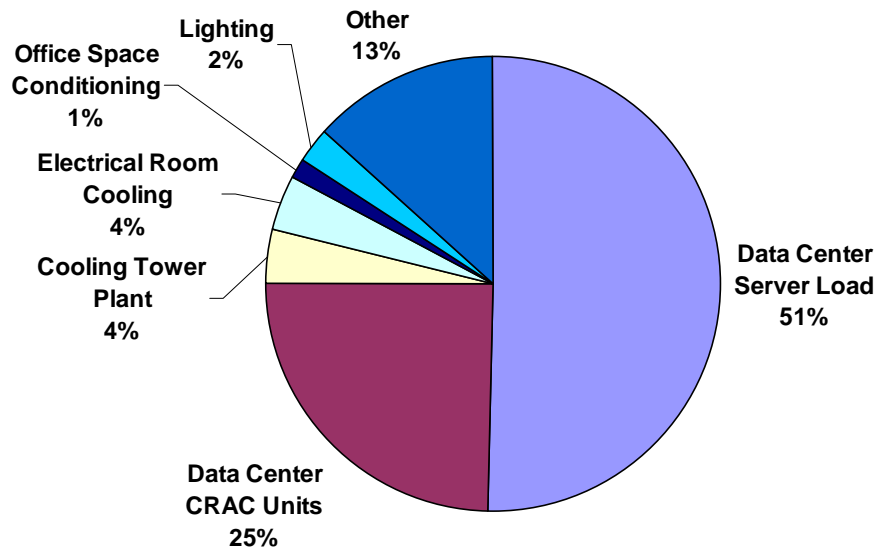
Presentation Outline

- ◆ LBNL Past Work
- ◆ Best Practice Development
- ◆ LBNL/CEC Efforts to Date
- ◆ New and Current Projects
- ◆ Anticipated Performance Evaluation
- ◆ Discussion

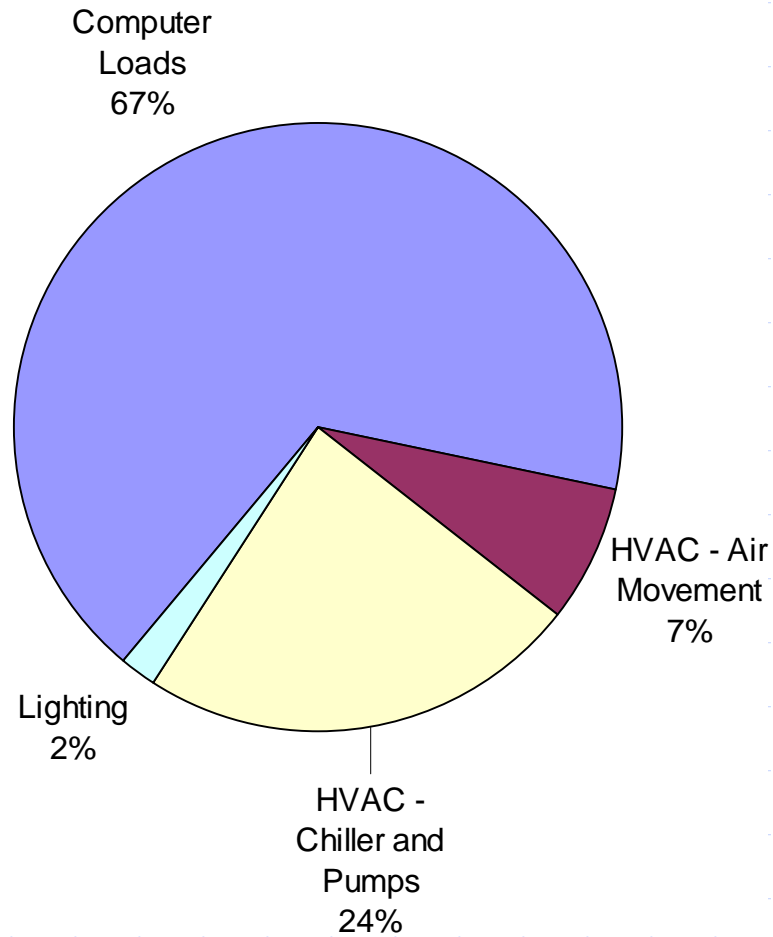
LBNL Past Work – Benchmarking

- ◆ The “market”
- ◆ Many myths exist concerning electrical loads
- ◆ Utility requests for power were unrealistic
- ◆ Data centers are energy intensive
 - Unknown efficiency improvement opportunity
- ◆ Energy Intensities are reputedly rising

Electricity in Data Centers

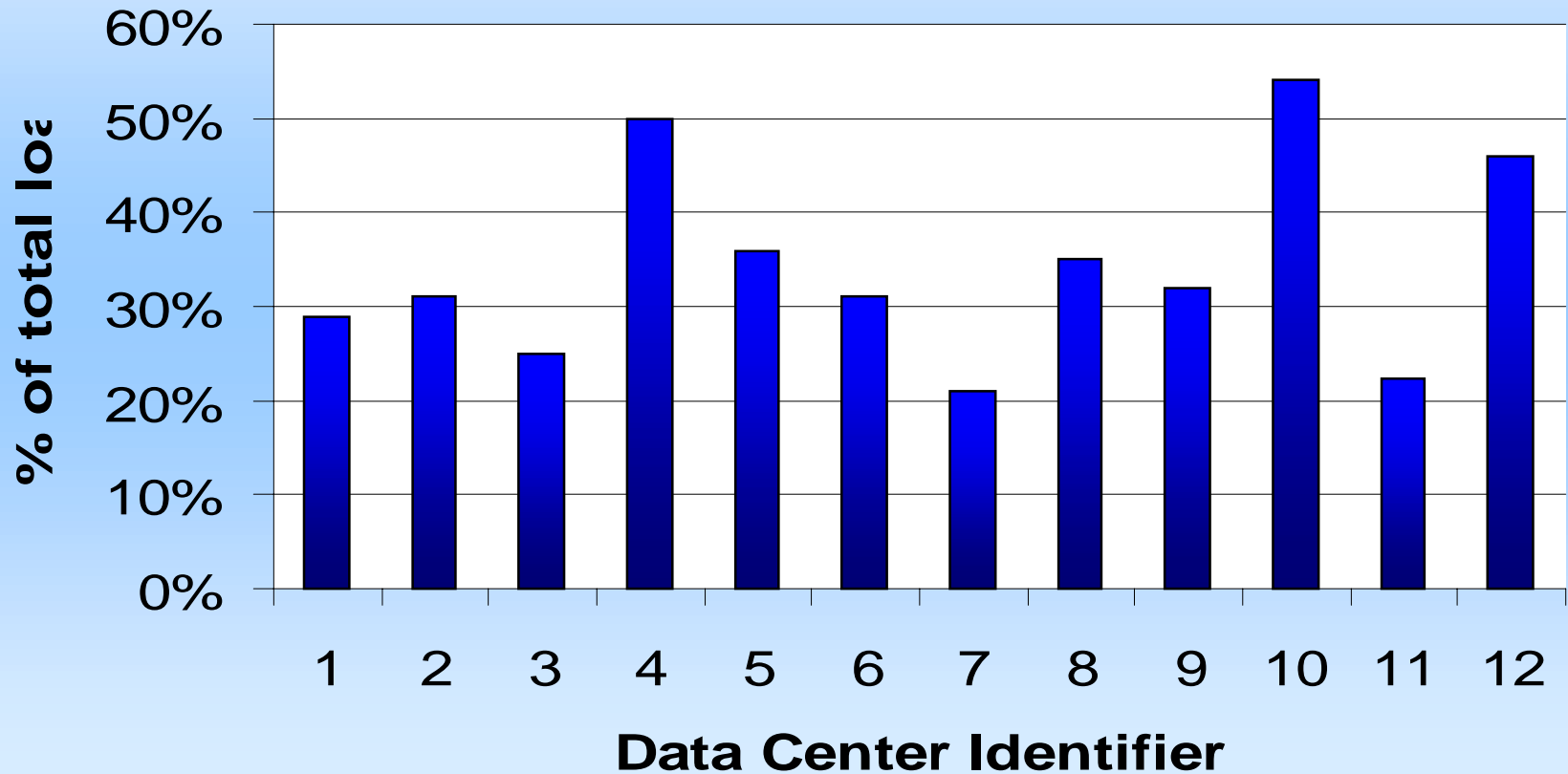


Better Ratio?

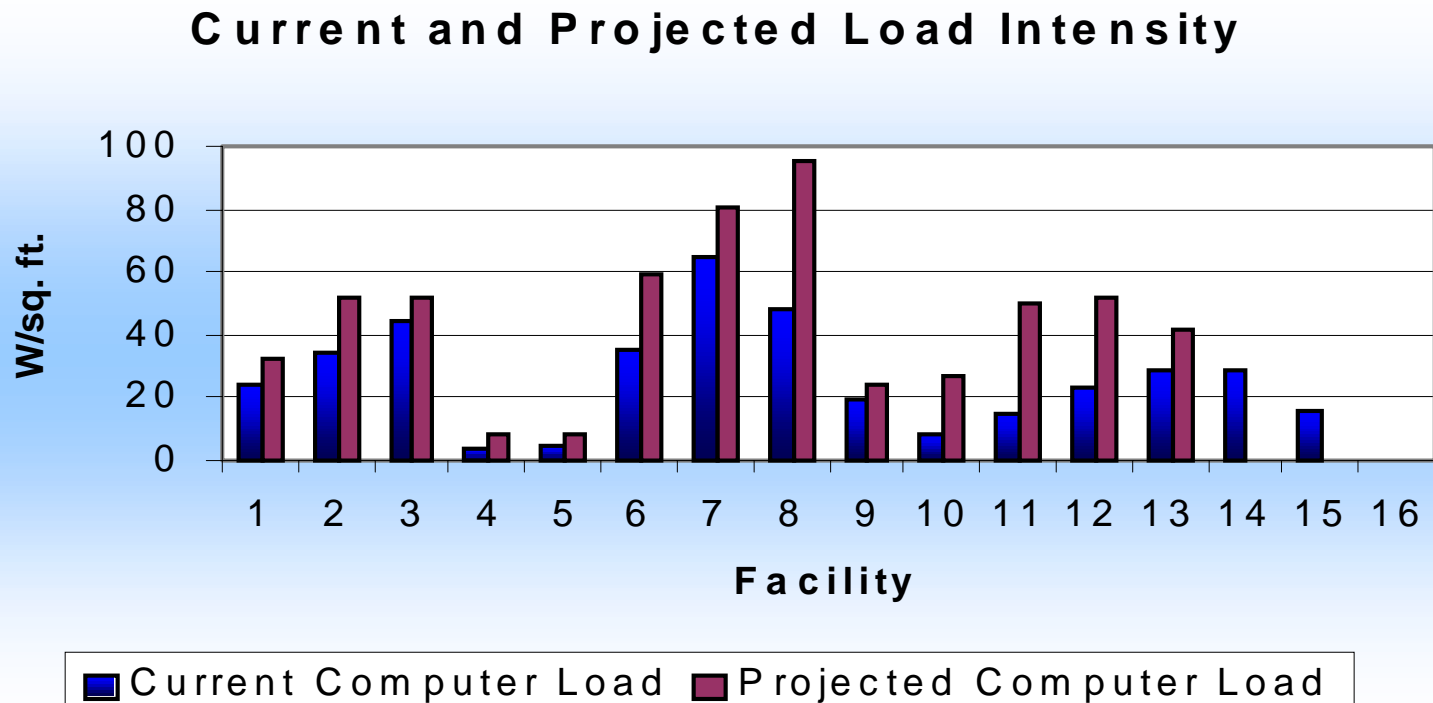


HVAC Energy

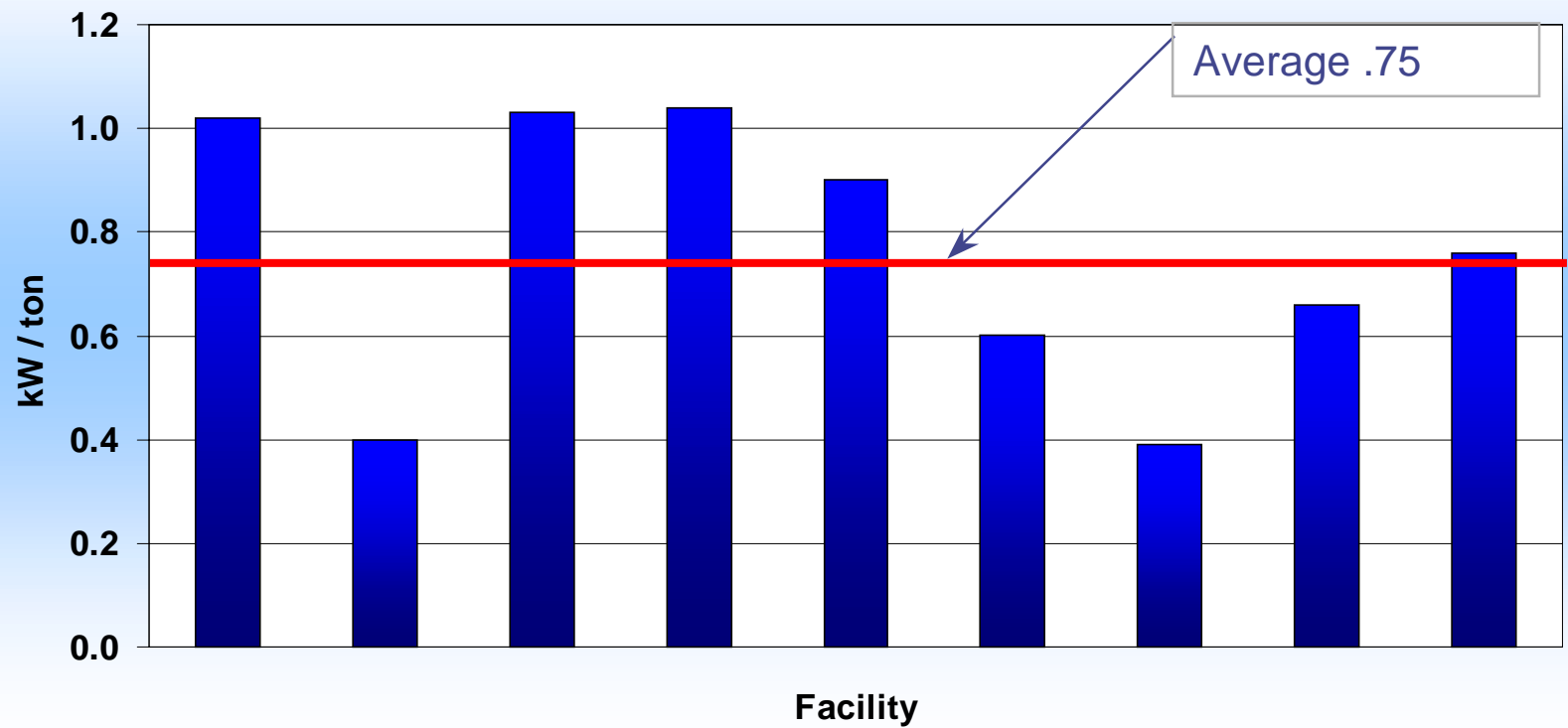
HVAC (as a % of total load)



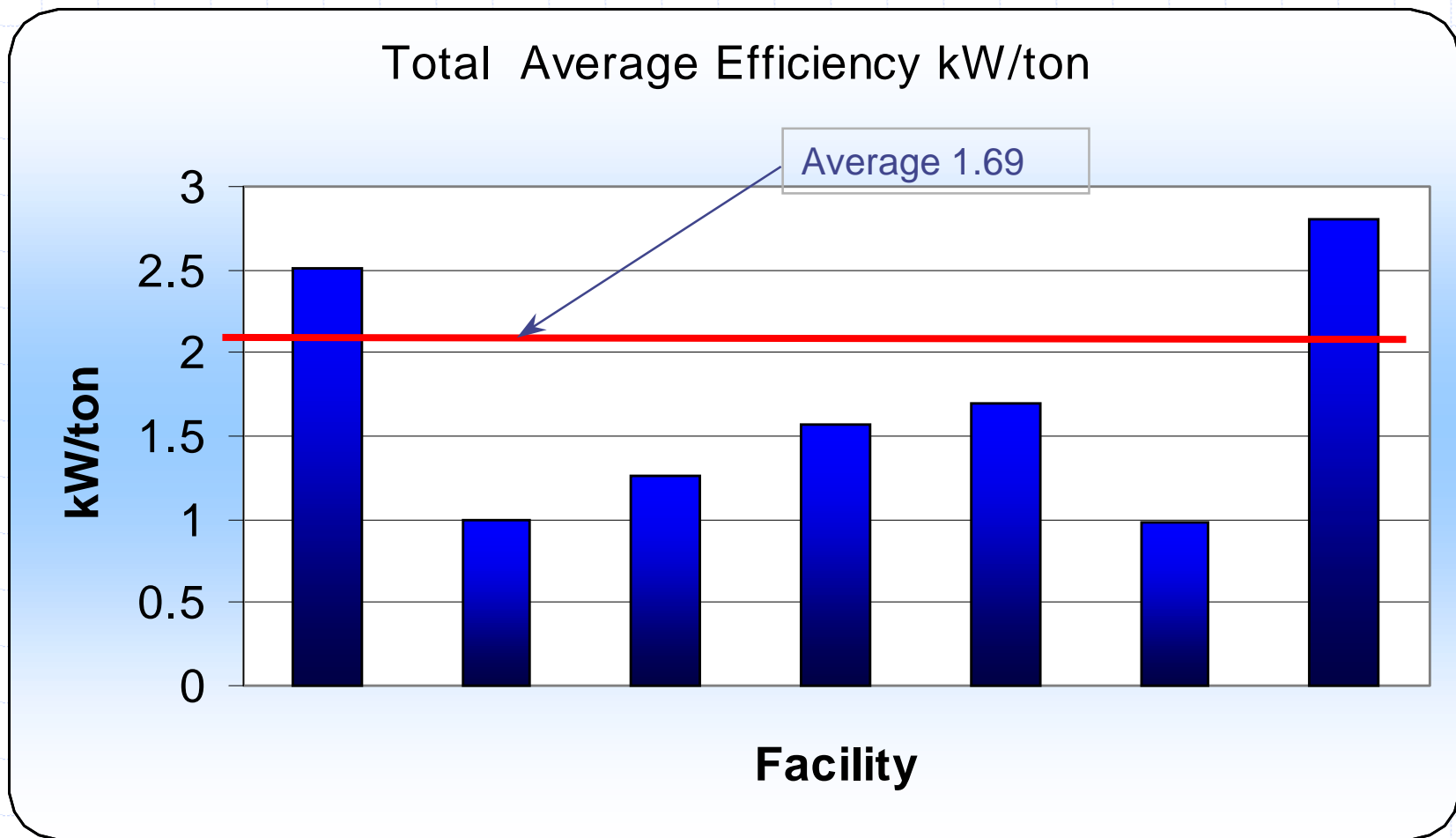
Projected Full Computing Load (Stipulated Maximum)



Chillers

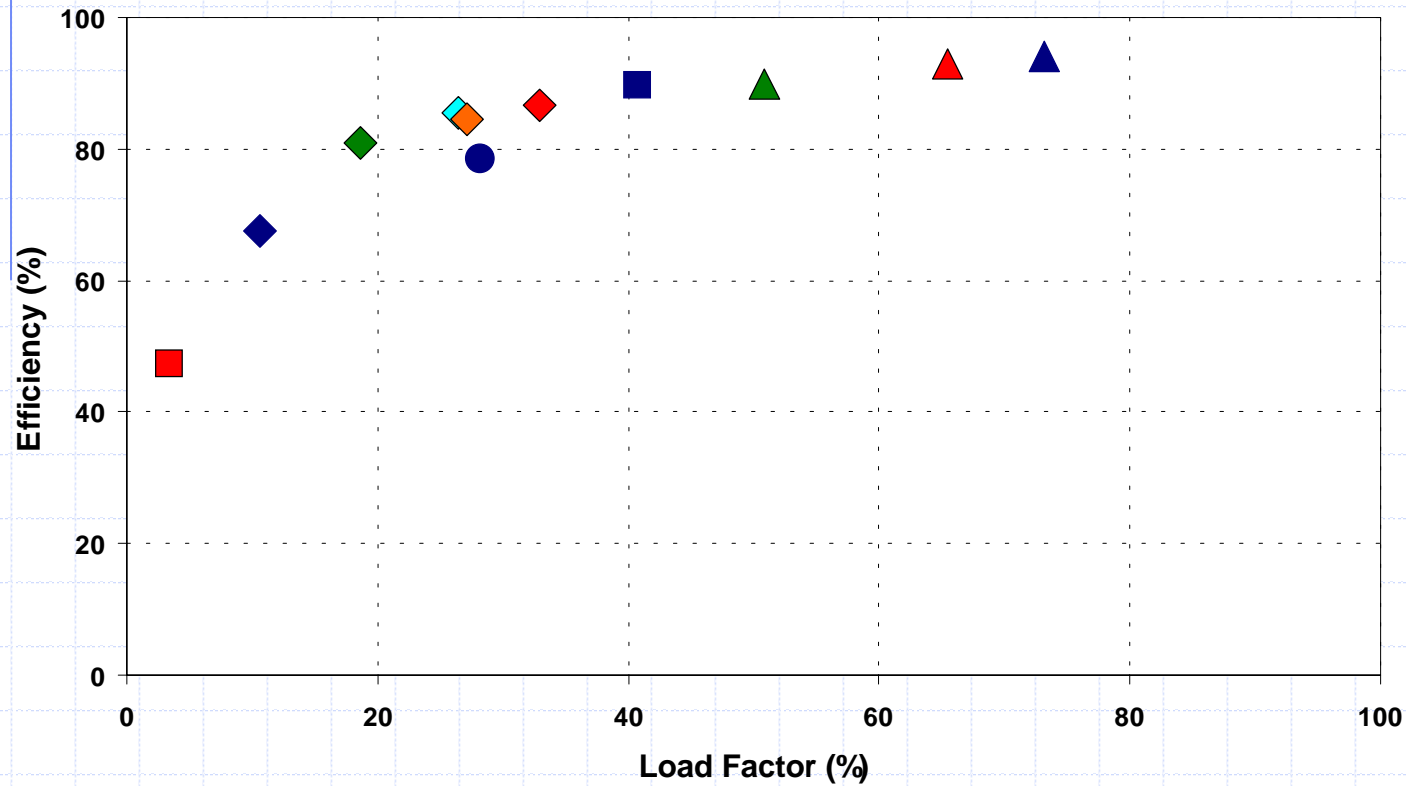


Total Chilled Water System



UPS

UPS Efficiency



Metrics

- ◆ IT Equipment Load Intensity – W/sq.ft.
- ◆ Infrastructure Load Intensity – W/sq.ft.
- ◆ Chilled Water Plant – kW/Ton
- ◆ Computer Room Air Conditioners – cfm/kW
- ◆ Central air handler(s) – cfm/kW
- ◆ Annual energy cost - \$/sf
- ◆ Annual energy use – kWh/sf/yr

Best Practice Development

- ◆ Benchmarking can identify best/better practices, e.g.,
 - Use of free cooling
 - Separate high temperature chiller
 - Use of multiple cooling towers
 - Reduce excess pumping
 - Recirculation air setback
- ◆ Benchmarking can spot maintenance problems

Efficiency Recommendations

Air Cooling

- ◆ Air Handler Efficiency
- ◆ Take Advantage of Thermal Stratification
- ◆ Air Management
 - Hot/Cold Aisles
 - Seal Openings
 - Temperature and Humidity

"Efficient" Reliability



UPS systems

- ❑ Configure to Operate Near Rated Load
- ❑ Compare System Efficiencies at Expected Operation
- ❑ Inertial vs. Battery Systems



Standby Generator Losses

LBNL/CEC Activities to date

- ◆ Case studies/energy benchmarking
- ◆ CA load characterization
- ◆ Energy research roadmap
- ◆ 1st Project Advisory Committee meeting – “High-performance Data Centers”



New and Current Projects

- Benchmarking and best practices
- Investigate UPS systems
- Investigate power supplies in IT equipment
- Collaborate on building interface developments

Anticipated Performance Evaluation

- ◆ Benchmark (measure) energy use in 6-10 data centers
- ◆ Develop self-benchmarking guidelines

Objectives

- ◆ Provide additional benchmarks and identify best observed practices. Communicate findings
- ◆ Market transformation through use of benchmarks to challenge conventional design, set operational goals, and identify where additional innovation is needed.

Strategy

- ◆ Identify benchmarking sites through industry and utility contacts
- ◆ Include standby generation losses
- ◆ Case study reports for each site
- ◆ Solicit additional benchmark data
- ◆ Review/Document all results to determine best performance

Self Benchmarking

- ◆ Develop protocol
- ◆ Owners and designers can obtain information in consistent manner
- ◆ Useful for comparison, baseline, trends
- ◆ More benchmarks will help identify best practices

Discussion

– Metrics for performance index

- ◆ Index of Performance = Building systems KW per UPS Output
- ◆ Computations per Watt
- ◆ Nameplate vs. Actual Comparisons
- ◆ Standby generator energy losses
- ◆ Others

Data Center websites

- ◆ <http://Datacenters.lbl.gov>
- ◆ www.upsite.com
- ◆ www.7X24exchange.org
- ◆ www.itherm.org

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